COBALT, FAST NEUTRONS AND PHYSICAL MODELS*

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ABSTRACT

Energy-averaged neutron total cross sections of cobalt were measured from ≈ 0.5 to 12.0 MeV. Differential elastic- and inelastic-scattering cross sections were measured from ≈ 1.5 to 10.0 MeV over the scattering-angle range $\approx 18^{o}$ to 160^{o}, with sufficient detail to define the energy-averaged behavior. Inelastic neutron groups were observed corresponding to "levels" at: 1115 ± 29, 1212 ± 24, 1307 ± 24, 1503 ± 33, 1778 ± 40, 2112 ± 40, 2224 ± 35, 2423 ± 39, 2593 ± 41 and 2810 keV. The experimental results were interpreted in terms of the spherical optical-statistical and coupled-channels models. An unusually successful description of observables was achieved over a wide energy range (<-15.0 to > 20.0 MeV) with a spherical model having energy-dependent strengths and geometries. The energy dependencies are large below ≈ 7.0 MeV (i.e., ≈ 19.0 MeV above the Fermi energy), but become smaller and similar to those reported for "global" potentials at higher energies. The imaginary strength is large and decreases with energy. These imaginary-potential characteristics are attributed to neutron shell closure and collective-vibrational processes. The latter are consistent with a weak-coupling model wherein the $f_{7/2}$ proton hole is coupled to the yrast 2^{+} state in ^{60}Ni, and with the observed inelastic scattering which clearly displays a non-statistical component. The weak-coupling model also offers an explanation of the unusual negative energy slope and relatively small radius of the imaginary potential. The spherical optical model derived from the neutron-scattering results was extrapolated to bound energies using the dispersion relationship and the method of moments. The resulting real-potential strength and radius peak at ≈ -10.0 MeV, while concurrently the real diffuseness is at a minimum. The extrapolated potential is $\approx 8\%$ larger than that implied by reported particle-state energies, and $\approx 13\%$ smaller than indicated by hole-state energies.

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